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MEDICAL NEWS LETTER

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The U.S. Navy Medical News Letter is basically an official Medical Department publication inviting the attention of officers of the Medical Department of the Regular Navy and Naval Reserve to timely up-to-date items of official and professional interest relative to medicine, dentistry, and allied sciences. The amount of information used is only that necessary to inform adequately officers of the Medical Department of the existence and source of such information. The items used are neither intended to be nor are they susceptible to use by any officer as a substitute for any item or article in its original form. All readers of the News Letter are urged to obtain the original of those items of particular interest to the individual.

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Radiation Exposure Aboard USS Nautilus

Increasing interest in the application of nuclear reactors to civilian industry indicates that radiation safety principles will in the future become a matter of widespread interest to the medical profession. Curiosity and possible public apprehension will require that all physicians have some basic knowledge of the field. More specifically, the increase in the percentage of the population exposed routinely to ionizing radiation may lead to confusing diagnostic and therapeutic situations. As more and more emphasis is placed on controlling lifetime exposure to ionizing radiation, radiologists, in particular, must be aware of the exposure patterns experienced by personnel employed in nuclear-power plants. Physicians associated with the practice of industrial medicine will play a large part in establishing industrial radiation safety codes and advising in on-the-job situations. Traumatic surgeons will find contamination by radioactivity a new factor to cope with in industrial surgery. Pre-employment routine physical examinations in this field will present important problems to the dermatologist, ophthalmologist, and hematologist who may be asked to advise on potential risk arising from chronic dermatitis related to skin contamination, lens opacities, and departure from normal hematology in personnel who are prospective employees in this field or who have already received significant industrial exposure.

Apart from these specialized problems, all physicians as professional men should be prepared to inform and advise their communities as reactor application becomes more widespread. A realistic knowledge of radiation safety is required for advice to a public already confused and apprehensive about a subject that is often, unfortunately, falsely and unrealistically linked to the "atom bomb" in the layman's mind.

This article discusses the radiation hygiene or "health-physics" program utilized by the USS Nautilus and describes the exposure pattern of

personnel encountered during the first year's operation. Although this is a specific program tailored to the unique situation existing aboard a submarine, it is based on the same general principles that will operate in any industrial application and illustrates a comparable exposure pattern.

In discussing the details of the submarine-reactor problem, it is well to emphasize four important concepts that one must bear in mind in evaluating any reactor radiation hazard to personnel:

> A shielded reactor, except in a casualty situation, produces a very low-grade type of radiation exposure to personnel at a dose rate far below that necessary to produce demonstrable biologic effects.
>
> Because present maximum permissible exposure levels are in practice so far below levels producing effects detectable by clinical or laboratory means, one is wholly dependent upon instrumentation to determine the rate of exposure and the integrated exposure received.
>
> There is little relation, qualitatively or quantitatively, between the radiation of an atomic bomb burst and those from an operating reactor even in the casualty situation.
>
> Present maximum permissible radiation exposures are educated and experienced estimates, usually with a large safety factor. One must be well aware of new concepts as further study indicates the need for revision and change in acceptable levels.

Further clarification of the first two points emphasized above is important in that they explain why such procedures as routine blood counts are inadequate in measuring human radiation exposure on an occupational tolerance basis. There are required, for example, some 20 to 40 r of total-body dose delivered rapidly, to initiate leukopenia, and yet the maximum permissible exposure is normally but 0.3 r per week. Thus, in establishing a good radiation control program, the physician finds himself dependent upon what at first appears to be a baffling array of instruments far different from that normally used in a clinical laboratory. Although one need not become an amateur electronic engineer, familiarity with this equipment is necessary, particularly, comprehension of its limitations regarding accuracy, sensitivity, and energy dependence. The third and fourth concepts listed appear simple, but represent a great deal of confusion, particularly, concerning the physiologic effect of these radiations. The shield physicist or engineer unacquainted with the variables and vagaries of biologic systems is apt to be baffled and disgruntled by the apparently fluid nature of permissible radiation levels. Translation and explanation of the latest biologic data for the physicist can be a very important and necessary contribution to reactor-shielding design.

Submarine radiation safety may be considered a special aspect of the environmental medicine and industrial toxicology that have always played a large part in the medical problems of submariners. Added to the conventional environmental problems of a true submersible is the necessity for formulation of an adequate radiation control program. Essentially, this program is

adapted from conventional health-physics policies and procedures at shore-based installations, but with important modifications necessitated by the submarine milieu. Familiarity with this milieu is necessary in order to understand some of the unique problems of a nuclear submarine.

As a general concept, the operational environment of a submarine is a reflection of the fact that a submersible ship is a microcosm, a small enclosed world that is home, factory, club, school, and recreation to its crew. In no other comparable military or civilian situation do human beings live in such intimate contact with their job environment—within a few yards of their work at all times. From the standpoint of maintaining minimal radiation exposure, this proximity appears disadvantageous. As a matter of fact, such an environment possesses factors both advantageous and disadvantageous to efficient radiation control.

The disadvantages inherently present in a submarine are:

> Nuclear submariners must live, eat, sleep, and work a few feet away from an operating reactor. This situation may be compared, for example, with the typical reactor installation on land where food preparation and food serving areas are several blocks away from the building which houses the operating reactor. On the Nautilus, food storage, food preparation and dining areas are within 80 feet of the reactor and its associated contaminated components. This requires maximum control of radioactive contamination and means practically that no surface or air-borne contamination is permitted in these areas.
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> The submariner's work week at sea is 7 days for 24 hours a day, compared to the industrial 40-hour week. This must be fully considered when given dose rate is related to stay time in a radiation area.
>
> In a submerged submarine the ship is operating independently of nature's atmosphere by constantly recirculating its own air. Thus, airborne radioactivity may be carried rapidly throughout the ship without dilution by the external atmosphere. In a comparable shore-based installation, dilution by external air may be a decisive factor in minimizing internal exposure. For this reason, the concentration of airborne activity permitted in submarines is ten-fold lower than acceptable levels in land-based reactor plants.
>
> The narrow confines of a submarine provide only minimum space for establishing monitoring check points for control of personnel leaving a contaminated area. Ideally, a check point is a large area complete with showers and multistaged checking areas. The ideal certainly cannot be achieved aboard an operating submarine.
>
> Decontamination of personnel and material is not destruction of radioactivity, but merely its removal to a more favorable location. It is difficult to visualize this "more favorable" location aboard a submarine. It does not exist.

The inherent advantages in the submarine environment that assist both the design engineer and the health physicist are:

Submarine construction divides the long cylindrical hull into a series of watertight compartments, any one or more of which may be isolated physically from the remainder of the ship by closing two watertight doors and two ventilation valves. This allows containment of contamination, whether surface or airborne.

The small number of personnel in a relatively small volume provides for ease of communication resulting in better control practices. Training programs are easily maintained with such a small cohesive group.

There is a lack of the multiple entrances and exits found in many shore-based reactor buildings. Each such exit from a potentially contaminated area must be guarded to prevent spread of contamination.

Full advantage can be taken of the fact that radiation produced by the reactor is proportional to its power and that during shutdown periods exposure is nil or minimal. The average dose received over a period is a function of the average power of the ship, not its maximum power level. It follows, therefore, that personnel may approach and somewhat exceed permissible levels of external radiation in any given week, but receive a weekly dose well below maximum permissible exposure as averaged over a recommended 13-week period.

The routine screening of potential submariners for intelligence, emotional stability, and mechanical aptitude provides a selected group of personnel. This factor has received little emphasis in radiation safety programs, but is of vital importance. An intelligent well-trained crew can provide an intangible asset ranking equally with distance and shielding in minimizing radiation exposure. The basic screening given nuclear submariners differs in no way from that of conventional submariners—indeed, at present, nuclear submariners are drawn from conventional submariners. This selected group, however, is capable of understanding the problem realistically and of providing great assistance to a radiation safety program. This is particularly important when the number of health-physics personnel is limited. As industrial use of reactors increases, more and more emphasis should be placed on comparable selection programs for industry.

Analysis of the advantages and disadvantages listed resulted in the ship's definitive radiation control program. The center of this program is a small, but well equipped, laboratory where the equipment necessary to carry out all procedures is located. This laboratory includes counter-scalers for both Geiger-Müller and scintillation counting, facilities for collecting air samples for routine checks of particulate activity, portable apparatus for shield equipment and personnel monitoring, equipment for

radiochemical analysis (including urinalysis), and necessary protective clothing. A very important part of the laboratory is devoted to the personnel photo-dosimetry program which includes a film-developing tank with automatic temperature control. Carefully standardized sources are carried for calibration of all instruments. This laboratory occupies an amazingly small space in comparison to shore-based laboratories. The effective floor space is less than 20 square feet, the remainder being utilized for instrumentation, storage, and work surfaces. The work surfaces occupy approximately 15 square feet.

The laboratory and its equipment are under cognizance of the ship's medical department, consisting of one medical officer and two hospital corpsmen. All have received from 12 to 20 months of training in radiation measurement techniques, radiobiology, and basic principles of reactor engineering. Similarly trained personnel have been assigned to the USS Seawolf, the second American nuclear submarine.

For understanding the radiation safety program and resultant radiation exposure patterns, a simplified description of a water-cooled power reactor such as the one used aboard the USS Nautilus is described.

In describing the individual exposure pattern in any reactor installation, one must stress the fact that film-badge or pocket-dosimeter readings do not give the total radiation dose because they give no indication of the status of internal radiation. These devices are sensitive only to external radiation, for example that due to sources outside the body. A true integrated dose must include both external and internal components. Internal radiation is produced by ingestion or inhalation of radioactive atoms associated with particulate airborne activity or with surface contamination. For this reason a continuous air-monitoring program must be maintained to quantitate the degree of inhalation hazard. Such exposure may be measured only after the fact by radiochemical urinalysis. Early detection and measurement before the actual exposure are far more desirable.

This dual nature of potential radiation exposure, external and internal, is emphasized because of the frequent misconception that a film-badge and pocket dosimeter provide all necessary metering functions for personnel. These devices meter only external radiation. Airborne particulate activity at, or near, permissible breathing concentration has little or no effect on the film-badge and dosimeter.

Individual external radiation exposure aboard the Nautilus is measured by two personnel-metering devices, the film-badge and pocket dosimeter.

Through such devices as these described, a continuous knowledge is available concerning potential exposure. This intelligence enables one to predict exposure rates, evaluate potential ingestion hazards, make recommendations concerning use of protective clothing, and determine stay times, necessity for decontamination, adequacy of shielding, and other factors. As an additional check of radiation exposure, a complete hematologic examination is done on the crew every 4 months, and a physical examination is

carried out annually. Certain special clinical procedures, such as examination with the slit-lamp lens, are also carried out at regular intervals. As emphasized, however, a radiation protection program cannot be based solely on clinical findings of this type because of the insensitivity of the human organism to radiation at permissible exposure levels.

With this background, the radiation exposure pattern during the calendar year 1955 is presented. This period marks the first year's operation of the ship during which an average crew population of 106 men were aboard. This crew population alone will be considered.

The present weekly permissible exposure to total-body penetrating radiation is, by Atomic Energy Commission and United States Navy standards, 300 milliroentgen equivalent man (mrem) per week (note that roentgen equivalent man is used instead of the classic roentgen). The roentgen applies, by definition, only to X or gamma radiation, but a reactor produces neutron and other radiations as well as X or gamma radiation. The use of the rem or millirem provides a single unit to express the integrated dose from all types of radiation. A rem is equivalent to 1000 millirem.

On the basis of a tolerance level of 300 mrem per week, the maximum individual annual total exposure is 15,000 mrem per year (15 rem), using a 50-week year. With this as a reference, the average annual exposure per man during this period was only 173 mrem per man per year or approximately 1% of the annual permissible amount of external radiation by present standards.

A further breakdown shows that 77 members of the crew actually received less than 33 mrem during the entire year—less than the permissible exposure for one week.

These extremely low exposures represent bias from the group of personnel in jobs that are not associated with the reactor and who, therefore, spend little or no time in the reactor compartment. The engineering ratings who do spend significant time in the reactor compartment might be expected to accumulate more exposure. Their average annual exposure shows an interesting comparison: annual average exposure (engineers), 468 mrem per man per year; and annual average exposure (entire crew), 173 mrem per man per year.

The maximum annual exposure to any one crew member was 1438 mrem or less than 10% of the annual permissible exposure.

It should be noted that these exposures not only are well below present recommendations of the National Committee on Radiation Protection, but also are below the conservative figures suggested by the National Academy of Sciences earlier this year in considering the genetic effects of ionizing radiation.

A further interesting observation was the pattern of exposure in operating versus shutdown periods. During reactor shutdown periods, when work is being carried on in the lower reactor compartment, residual radiation is present beneath the shield. The effect of this residual radiation is illustrated by a comparison of the average total exposure received by personnel during

three periods each of 14 days' duration: average total exposure 3 operating periods, 689 mrem per 14 days; and average total exposure 3 shutdown periods, 2118 mrem per 14 days.

In the second case all the exposure is received by engineering ratings who work in the lower compartment. This tends to raise their annual exposure as noted above. This further illustrates that radiation control does not stop with reactor shutdown, but is equally important during maintenance periods.

No significant internal exposure occurred in relation to the reactor system. Incongruously, the most important airborne radioactivity problem was related to radium-painted dials and wrist watches carried aboard. Radium in the luminescent paint of dials decays to its daughter isotope, radon, a radioactive noble gas. Radon is emitted into the atmosphere from these dials and, with its daughter isotopes and associated dust particles, is detected by air-sampling equipment. The radon air concentration, varying with time submerged and dust concentration, occasionally reached within 10% of the permissible value during prolonged submersion. Apart from its biologic effect, radon interferes with air-sampling equipment and may be falsely interpreted as a true coolant leak originating within the reactor system. The solution was removal of all radium-bearing dials and watches from the ship with satisfactory results. This effect also rules out the use of radium as a calibrating source and adequate substitution was made with the use of cobalt 60.

Surface contamination during this period was not detected outside the lower compartment. The levels in the lower reactor compartment did not exceed 200 counts per minute per square foot except inside the coolant system where expected high levels were encountered during maintenance.

Physical examinations, including routine hematologic and slit-lamp lens studies, revealed no abnormalities due to ionizing radiation.

The future increasing need for profession-wide knowledge of radiation control practices is emphasized. The radiation control program used aboard the USS Nautilus is described and is presented as a unique application of radiation safety principles. The radiation exposure pattern during a year's operation of the ship is presented, stressing the very low exposures encountered. It is believed that, given similar good engineering design and conservative shielding practices, this pattern can continue in nuclear installations of the future. (LCDR John H. Ebersole, MC USN, Radiation Exposure Patterns Aboard the USS NAUTILUS: The New England J. Med., 265: 67-74, January 10, 1957)

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Please forward requests for change of address for the News Letter to: Commanding Officer, U.S. Naval Medical School, National Naval Medical Center, Bethesda 14, Md., giving full name, rank, corps, and old and new addresses.

Friedländer's Bacillus Pneumonia

Monumental advances in the therapy of pneumococcal pneumonia over the past 15 years have given the physician a justified confidence that with modern antibiotics the outcome of a case of pneumonia will usually be favorable. Caution is needed lest this confidence be applied uncritically to every case and, thereby, efforts relaxed to discover uncommon but stubborn bacterial species which may infect the lung. Acute Friedlander's bacillus pneumonia, although accounting for only a small percentage of such infections, still carries a sufficiently high mortality to make imperative its early recognition and the early institution of appropriate therapy.

Thirty cases of acute Friedländer's bacillus pneumonia were admitted to the Cincinnati General Hospital between 1939 and 1956. The mortality in the 15 cases treated prior to 1948 was 73%, whereas that in patients treated subsequent to 1948 was 53%. Although this difference is not statistically significant, the decrease, when considered in conjunction with similar experience in other hospitals, indicates that modern treatment improves the outlook in this still very serious infection. Penicillin is of no value whatever. Sulfonamide treatment seems a little more effective and treatment with streptomycin and tetracycline drugs, better still.

Bacteremia was associated with a very high mortality. The only two survivors among 15 bacteremia cases were treated with a combination of streptomycin, a sulfonamide, and a tetracycline drug.

From their cases, the authors gained the following impressions: (1) that a high fatality rate ensues with either no therapy or with penicillin only; (2) that treatment with sulfonamides represents a slight improvement over this; (3) that treatment with the tetracycline drugs or streptomycin represents a still further improvement, and (4) that there may be some added advantage to the early use of tetracycline drugs in treatment.

It is interesting that of the 15 bacteremic patients in this series, only two survived the infection and both were in the "modern treatment" group This observation is in contrast to that of Solomon who noted that bacteremia did not influence the mortality in this disease. It is also interesting that blood cultures were positive in 71% of the cases where they were drawn in the group treated before 1948 while the incidence fell to 38% in the 1948-1956 group.

Single or multiple lung abscesses developed in 7 of the 30 cases. Four patients were under treatment with sulfonamides at the time of x-ray appearance and three under treatment with streptomycin and tetracycline drugs. Survivors from each treatment group showed evidence of residual chronic pulmonary involvement.

It is essential to distinguish Friedländer's pneumonia from pneumococcal pneumonia as early as possible so that therapy other than penicillin may be instituted. Differentiation on clinical grounds alone may be impossible.

Diagnosis may be made earliest by finding the organism in a Gram-stained smear of the sputum. If typing serum is available, a more specific diagnosis can be made by direct typing of the organisms from the sputum.

The authors believe that until a more effective agent is discovered for the treatment of his disease the patient is offered the best opportunity when treated early with a combination of antibiotics. They currently use a combination of a tetracycline drug (2 gm. per day), streptomycin (2 gm. per day), and a sulfonamide (4-6 gm. per day).

Although the antibiotic sensitivity of different strains of K. pneumoniae may vary, most strains are sensitive to streptomycin and the tetracycline drugs. On the other hand, resistance to streptomycin may develop while treatment with this agent is in progress. Hence, in vitro sensitivity studies become an important guide in the management of a given case. Under no circumstances, should therapy be witheld until the result of such studies is available.

In contrast to the uniformly good results achieved in the treatment of pneumococcal pneumonia, the high mortality in Friedlander's pneumonia despite treatment with drugs quite effective in vitro represents a continuing challenge. Undoubtedly, the thick tenacious exudate which occurs in this infection plays a role in hindering the efficacy of presumably adequate chemotherapeutic drugs. Perhaps the addition of some—yet to be discovered—mucolytic agent will further reduce the mortality. (Jervey, L. P., Jr., Hamburger, M., The Treatment of Acute Friedländer's Bacillus Pneumonia: Arch. Int. Med., 99: 1-7, January 1957)

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Pregnancy During Hodgkin's Disease

In the practice of obstetrics, the complication of pregnancy by Hodgkin's disease is a rare event. In the practice of the physician who sees large numbers of lymphoma cases, this complication is by no means rare because the onset of Hodgkin's disease usually occurs with the child-bearing period and appears to have little effect on pregnancy rate. Thus, it is of interest and importance to know the possible effects of Hodgkin's disease on the course of pregnancy and on the child and, conversely, the effect of pregnancy and labor on the course of Hodgkin's disease. There have been many previous publications on this subject, each of which reports from one to twelve new cases of pregnancy complicating Hodgkin's disease for a total of approximately one hundred and fifty cases reported to date. The conclusion reached in several of these reports is that Hodgkin's disease does not affect pregnancy and pregnancy does not influence the course of Hodgkin's disease. The present study was undertaken because the experience in Memorial Center for Cancer and Allied Diseases does not permit unqualified acceptance of those conclusions and because it is apparent that the small number of cases presented

in previous series did not permit consideration of the tremendous variability in the natural course of this disease.

A card was prepared for each pregnancy on which the following data were recorded: basic identifying data; outcome of pregnancy; health of child to last available record; breast feeding; date of conception; date of onset of Hodgkin's disease by history; date of tissue diagnosis of Hodgkin's disease time in months from onset of Hodgkin's disease (by history and by tissue diagnosis) to death, and from conception to onset of Hodgkin's disease; and extent, location, symptomatology, progression, and treatment of the Hodgkin's disease during pregnancy, during the 9 months preceding conception, and during the 9 months after delivery.

The extent of disease was designated according to Craver's classification. Class I is unicentric disease without constitutional symptoms or other evidences of dissemination. Class II disease is characterized by involvement of two adjacent areas, suggesting spread from the point of origin along lymphatic channels to regional lymph nodes. There may or may not be constitutional symptoms. The commonest example of Class II Hodgkin's disease is that with masses limited to mediastinum and neck (unilateral or bilateral). Class III disease is generalized and often accompanied by constitutional signs and symptoms, such as pruritis, night sweats, fever, and anemia.

This classification is used to indicate maximum detectible extent of disease. Because complete eradication of the disease can never be presumed. It follows that the class designation cannot diminish. However, all evidence of disease activity may disappear and, if an area of disease shows no activity for a long time, the disease is considered dormant (rather than cured). In this study, a patient is designated as having dormant disease (of Class I, II, or III) if no anti-Hodgkin's disease treatment was given and there was no evidence of disease activity in any area for a period of at least 9 months.

Fifty-nine patients with Hodgkin's disease complicated by pregnancy were studied. Dates of onset ranged from 1925 to 1955. Age at onset of Hodgkin's disease ranged from 19 to 37 years. These fifty-nine patients had a total of 133 pregnancies, fifty of which were completed before onset of Hodgkin's disease. The other eighty-three pregnancies were concurrent with the Hodgkin's disease. Twenty-one patients had pregnancies both before and after onset of Hodgkin's disease.

In reviewing these charts the authors were impressed by two general facts. First, many patients whose disease was long dormant went through their pregnancies uneventfully. Second, many patients whose Hodgkin's disease started during pregnancy never responded well to treatment and ran a rather rapid course. Twenty-six patients had onset of Hodgkin's disease during pregnancy and thirty-three entered pregnancy with pre-existing Hodgkin's disease. Data on survival are tabulated separately for living and dead patients in each of these two groups and are also calculated for all patients in both groups. In patients with the onset of disease during pregnancy

the mean survival time was between 40 and 50 months, whether considering the living, the dead, or the combined groups.

Among those patients in whom conception occurred after the onset of Hodgkin's disease, the mean survival times were twice as long.

Obviously, if Hodgkin's disease starts during pregnancy, there is coincidence of Hodgkin's disease activity with pregnancy, whereas, a few patients with onset of Hodgkin's disease prior to conception entered pregnancy with dormant disease as a result of effective and adequate treatment. The mean survival time for those with dormant disease is longer (128 months) than for those with active disease (75 months), and the difference is probably significant. Comparison of these two groups with those patients who had onset of disease during pregnancy shows that the prognosis for survival is unquestionably best if Hodgkin's disease is dormant prior to conception. Among patients who entered pregnancy with active Hodgkin's disease, the mean survival was greater (75 months) than for those with onset during pregnancy (46 months), but this difference could more readily be due to chance.

If the possibility is accepted that pregnancy may have a deleterious effect upon the patient with Hodgkin's disease, there still remains the vital question of whether therapeutic abortion will improve the prognosis. The authors have found this almost impossible to assess from their data because when abortion was considered necessary, it was followed promptly by specific anti-tumor therapy. However, in two patients who had therapeutic abortions, a spontaneous partial regression of masses was reported for the few weeks that elapsed between abortion and radiotherapy. It was not possible to compare the average survival time of patients with and without therapeutic abortions because there were only four patients in this entire group in whom all post-Hodgkin's disease pregnancies were aborted. In these four patients, the survival times were 86, 104, and 112 months with one patient still living and well 9 months after onset. In these patients, prognosis for long survival was best if the Hodgkin's disease was inactive for at least 9 months prior to conception (ten patients - mean survival 128 months). No data were available from a nonpregnant population for comparison of survival time.

Spontaneous abortions occurred in pregnancies complicated by Hodgkin's disease only in those patients who had active disease before and during pregnancy and more frequently in patients with intra-abdominal or disseminated disease or both. Follow-up of children born of mothers with Hodgkin's disease was inadequate, but in the available data there was no evidence to indicate that these children were adversely affected by the mother's illness.

Although this study indicates that pregnancy is medically undesirable in the patient with active Hodgkin's disease, it permits no conclusion as to the value or lack of value of therapeutic abortion. (Southam, C. M., Diamond, H. D., Craver, L. F., Pregnancy During Hodgkin's Disease: Cancer, 9: 1141-1146, November-December 1956)

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Surgical Excision of Psoas Abscesses

This article describes an operation for the excision of psoas abscesses or sinus tracts arising from tuberculous lesions of the spine and describes the results of the operation in a group of thirteen patients. The procedure consists in the extirpation of the abscess together with any bony and cartilaginous sequestra which may be free in the tract or lodged in the diseased vertebral bodies. It is designed for use in those patients in whom treatment by simpler means has failed or is considered likely to fail because of the great size of the abscess, its chronicity, or its involvement with mixed bacterial infection. While the treatment is primarily directed at eliminating the psoas abscess, it may also be used as a means for the healing of the osseous and cartilaginous disease which is the source of the abscess.

The practice has been to limit the treatment of these lesions to simple aspiration or to incision and drainage when spontaneous perforation appeared to be imminent. There has been a reluctance to resort to incision and drainage because of the likelihood that the abscess would, thus, be converted into a permanent sinus.

The situation today is quite different from that prior to the introduction of antibiotics and other types of modern antibacterial drug therapy. With the protection given by the new drugs, operations may be performed upon tuberculous lesions with the same degree of safety and chances for success as operations of corresponding magnitude upon nontuberculosis lesions. The excellent results reported by Deroy and Fisher are evidence of the value of streptomycin in the treatment of tuberculous disease of the vertebrae and other bones. These observations should not be interpreted as meaning that streptomycin or other antibacterial drug therapy alone or combined with surgical treatment fulfills the requirements for the healing of tuberculous lesions of bone or other tissues. There is much to support the thesis that rest is still the most important means for obtaining long-term satisfactory results; and in the case of vertebral tuberculosis, immobilization following posterior fusion operations and adequate splinting by means of a cast and brace are recognized as essentials in satisfactory programs of treatment. What can be said definitely on the basis of experience with antibiotic and other drug therapy, thus far, is that these drugs act efficiently as agents for protection against dissemination of bacteria during operative procedures.

There are several reasons why the results of incision and drainage are frequently disappointing. Constrictions within the tract, tortuosity, and irregular out-pouchings interfere with free drainage following incision or spontaneous opening. Bony and cartilaginous sequestra which are usually present within the tract are capable of preventing permanent healing. Often, what appears to be complete healing after incision and drainage is followed months later by reopening of the sinus. The authors have seen several instances of recurrence of drainage following complete removal of the sac.

For these reasons they prefer total excision of the sac when this can be accomplished with safety. There are occasional patients in whom not all parts of the sac can be removed because of dense adhesions in hazardous areas; in these patients, curettage is used to destroy the lining membrane of the retained portions. In the several patients in whom this procedure has been resorted to, the results have been satisfactory thus far after one to several years of observation. However, permanent healing may not be as likely with incomplete removal and curettage of remaining portions as it is with total excision. Probably it is more than a coincidence that the only failure of healing in the group of patients operated upon was in a patient in whom an unexcised portion of the sac in the sacral fossa was not curetted.

The patients in this group were all adults who were judged to have had spinal tuberculosis for some years, although the disease was not recognized in two of them until several months prior to the excision of the abscess or sinus tract. The length and intensity of previous antituberculosis therapy varied considerably and in some cases it was entirely inadequate. Poor therapy was usually the result of lack of cooperation on the part of the patient.

Excision of the abscess and sequestrectomy have been performed in thirteen patients with known tuberculous disease. There have been no deaths. The only serious operative complication was complete severance of the femoral nerve during dissection of the pelvic portion of a sinus tract. In this patient the portion of the nerve between the psoas and iliacus was obscured by inflammatory tissue. The severance was recognized at once because of the accompanying forceful jerk of the thigh. Immediate repair by a member of the neurosurgical staff was followed by complete return of function to the quadriceps femoris.

The operation has resulted in the arrest of the disease in all but one of the patients. The one failure is accounted for by the known incomplete removal of the sac. All of the patients have gained weight and all show the general improvement in health which one would expect following the removal of an empyematic sac. Several are gainfully employed for the first time in years. These results gain significance when it is realized that all were adults in whom the disease was firmly entrenched and that a majority had had draining sinuses for months or years. Coexisting active or inactive tuberculous disease in other sites was the rule rather than the exception, with pulmonary and genito-urinary lesions predominating. Ten of the thirteen patients had been previously treated by streptomycin with the addition of isoniazid or para-aminosalicylic acid or both without favorable response. Four of the patients had firm fusion of the vertebrae of the involved region as a result of a previous operation, indicating that the suppurative lesion had progressed in the presence of a solid ankylosis. In view of the failure of previous therapy, it would appear that excision of the abscess was the necessary additional factor needed to arrest the disease.

While the long-term results cannot be predicted on the basis of observations made in so few cases over a relatively short period of time, the favorable response in these patients who have been observed for variable periods up to 6 - 1/2 years, establishes the practical value of this procedure which is designed to heal psoas abscesses or sinuses resulting from tuberculous caries of the spine. (Weinberg, J. A., The Surgical Excision of Psoas Abscesses Resulting from Spinal Tuberculosis: J. Bone & Joint Surg., 39-A: 17-26, January 1957)

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Vascular Prostheses

Within the past 5 years, increasing indications for excision or by-pass procedures in the treatment of aortic and peripheral arterial lesions have created a demand for vascular substitutes out of proportion to the available supply of arterial homografts. Thus, the need for a suitable vascular prosthesis made of commercially available materials has become acute. As a result of this need, a variety of materials—largely synthetic—has been investigated in experimental animals and in humans. From this experience, significant data relating to operative technique and the early behavior of these materials after transplantation have been derived. In spite of these studies, however, there has been considerable difficulty in evaluating the results obtained with synthetic vascular substitutes largely because of the many different types of material in use and the fact that no one investigator's experience is large enough to be conclusive. Recognizing the importance of this problem, the Society for Vascular Surgery, at its annual meeting in 1955, appointed a Committee for the Study of Vascular Prostheses. This report is concerned with the findings of this committee.

The study was conducted along the following lines: (1) Available data were collected relating to types of materials used including the composition and properties of the crude materials, methods of fabrication, and properties of the finished prostheses. (2) Results of experimental and clinical trials with these materials were collected. (3) Failures were analyzed in terms of material, technical features, and other factors contributing to failure. (4) Observations on the biologic fate of synthetic prostheses after transplantation were assembled. (5) Opinion of members of the Society and others in vascular surgery was determined with regard to the essential features of synthetic vascular substitutes.

Eight basic materials were used for vascular substitutes: Vinyon-N, nylon, Orlon, Dacron, Ivalon, Teflon, Fortisan, and stainless steel. These materials were fabricated into 17 types of prostheses, two of which were nonporous and the remainder were porous. In three instances, the prostheses were made commercially while the rest were constructed by the surgeon. A description of the essential features of these materials is included.

The results of this study clearly indicate that vascular prostheses made of synthetic materials may be used effectively as aortic replacements. In fact, the reported 93% of successful results in 256 cases compare favorably with the experience with homografts. From a functional standpoint, synthetic vascular substitutes appear to be quite as satisfactory as homografts. Similarly, the acceptance of these materials by recipient tissues is little different from that observed with homografts, that is, both produce a moderate inflammatory reaction and eventually become incorporated into recipient tissues largely by growth of fibrous connective tissue. The ultimate morphologic appearance of synthetic prostheses or homografts has not yet been determined, but from a few observations made at 2 years, degenerative changes appear more likely to develop in typical atherosclerotic lesions in human aortic homografts from 1 to 2-1/2 years after transplantation. Synthetic prostheses are more difficult technically to use and are less adaptable to varying aortic diameters than are homografts. In addition, the pervious prostheses bleed momentarily until clotting occurs in the interstices and this may constitute a serious problem as indicated by the report of two deaths resulting from uncontrollable hemorrhage through the walls of the prostheses.

Although experience with aortic substitutes is encouraging, it must be emphasized that the aorta is not a critical proving ground for vascular prostheses. The large diameter of the aorta and its major branches and the velocity of blood flow through them render the possibility of luminal occlusion from thrombosis unlikely irrespective of the types of material used. On the other hand, a peripheral artery, because of its relatively small size, great length, and crossing of flexion areas, must be replaced by a prosthesis more closely approximating in physical properties a natural artery if satisfactory function is to be obtained. Of all the materials investigated, none meet these criteria at the present time. For this reason, the committee believes that increasing emphasis should be placed on investigation of synthetic substitutes for peripheral arteries. To be sure, crimped nylon tubes and Dacron taffeta prostheses are being employed successfully in a number of instances; however, the follow-up period is relatively short and successful results have not been uniformly achieved.

In regard to properties of the ideal vascular prosthesis, the committee was of the opinion that inertness, flexibility, ability to retain its shape, and ease of handling were desirable qualities. Elasticity is probably not essential. The presence of seams is unimportant, but the necessity for construction of seams as strong as the material itself is emphasized by the report of two instances of disruption of a prosthesis at the seams. In view of the results noted in one impervious aortic substitute examined 2 years after transplantation, it appears that additional experience with impervious materials is needed in order to determine the desirability of, or necessity for, material through which connective tissue cells can grow.

It appears that synthetic replacements need have less critical characteristics for use in the aorta. Construction of prostheses by weaving, braiding, or knitting has been found satisfactory. The most satisfactory materials appear to be Dacron and Teflon at the present time. Vinyon-N cannot be autoclaved and is not made commercially as yarn. A significant loss in tensile strength has been observed in experimental aortic replacements of nylon and Orlon taffeta. A complete evaluation of Ivalon is not possible at the present time, but there have been more failures from rupture or thrombosis reported with this material than with all others. In peripheral vessels, a lesser degree of success has been achieved than in the aorta and with braids of nylon. For proper evaluation of replacement of peripheral vessels, the committee plans a more detailed investigation of selection of patients and technique of implantation in cases to be reported in the future.

It must be emphasized that this is a preliminary report and the data presented are not complete and do not represent the total experience with vascular prostheses. (Creech, O., Jr. et al., Vascular Prostheses - Report of the Committee for the Study of Vascular Prostheses of the Society for Vascular Surgery: Surgery, 41: 62-80, January 1957)

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Correlation of the Inclined Planes of the Articular Surface of the Glenoid Fossa with the Cuspal and Palatal Slopes of the Teeth

The assumption that a relationship exists between the articular tooth surfaces and the articular plane of the temporomandibular joint is usually made. Complete and partial dentures are designed on this basis. Contrary to this point of view is the observation that the teeth do not contact during mastication.

From the evolutionary point of view, postural changes are possible underlying factors for the formation of the human fossa mandibularis. Studies of the masticatory muscles as well as of the histology of the temporomandibular joint suggest that the joint is subject to functional stresses. Although the form of the cranial bones may be modified through masticatory muscular function, evidence for a role played by the dental structures in cranial form is inconclusive.

In the studies, it appeared that if exact measurements of the joint and tooth surface inclinations were made, the resulting data could be correlated so as to secure evidence relating to this problem. The results of these studies are:

1. An instrument was constructed to measure in millimeters the 3 dimensions of the glenoid fossa and the dental cusps.

2. The articular slope of 20 fossae and the cuspal and palatal slopes of the maxillary teeth in 10 skulls were studied in order to determine if any correlation between these units existed. The skulls selected had to conform with the following requirements: normal occlusion, nonabraded cusps, and an amount of overbite between 1 to 5 millimeters. Within these limitations of control, the skulls were chosen at random.

3. The anterior slope of the fossa and the inclined planes of the cusps and palatal slopes were measured and recordings made. Their slopes were determined in units of degrees.

4. The collected data were subjected to statistical analysis which gave the following results: (a) The anterior slope of the glenoid fossa shows great individual variation both within the sample group and within each skull; (b) The teeth exhibit a greater constancy in their inclined planes and show less variation between the two sides of one and the same skull, although the palatal slopes of the upper anterior teeth show greater individual variations than the cuspal slopes of the posterior teeth; (c) No significant difference was found between the main slope of the articular surface of the glenoid fossa and this of the palatal slope of the upper anterior teeth, although the mean cuspal slope was found significantly different; (d) The correlation found between the articular slopes of the fossae and the dental slopes (both cuspal and palatal) appears significantly different from zero at the 0.05 level; (e) All the statistical methods applied seem to indicate a closer relationship between the articular slope of the fossa and the palatal slope of the upper anterior teeth, the correlation to the cuspal inclines of the posterior teeth being less significant; and (f) On the basis of this study alone, no definite conclusions can be made if and to what extent the teeth have a functional influence upon the configuration of the articular surface of the glenoid fossa. (Koyoumdjisky, E., J. Dent. Res., 35: 890-901, December 1956)

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Applications for Training in Diving and Submarine Medicine

Applications for the eight weeks' course in diving medicine are solicited at this time for a course beginning early in May 1957. These is no obligation for extended service connected with this course. Those who complete it will be assigned to shore-based activities which engage in diving or underwater swimming. These billets do not have any additional pay inducements at this time. Those assigned to these billets may reasonably expect to complete a full tour of duty at this assignment.

A few vacancies remain in the submarine medicine course which will convene in July 1957, and several in the class convening in January 1958.

This is a six months' course and requires an obligation to serve six months beyond any current obligation or one year after completion of the course, whichever is longer. This course includes both submarine and the diving medicine course described above. Those who complete the course are usually assigned to billets which have an associated extra pay for hazardous duty. Graduates of this course also are eligible later for postgraduate training for service with nuclear powered submarines, in occupational medicine billets, in physiological research or the clinical residency program.

Application may be made by submitting a letter of request addressed to the Chief, Bureau of Medicine and Surgery, Navy Department, Washington 25, D. C. (Attn: Professional Division). Physical qualifications are given in Manual of the Medical Department, Articles 15-29 and 15-30. Requests for waivers of minor defects will be given individual consideration (SubMed-Div, BuMed)

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Trudeau School of Tuberculosis
Saranac Lake, New York

The Trudeau School of Tuberculosis will present its Forty-second Annual Session commencing Monday, June 3rd and concluding Friday, June 21st, 1957. The concentrated three weeks' course will cover all aspects of pulmonary tuberculosis and also certain phases of other chronic chest diseases, including those of occupational origin.

As in the past, the clinical material for the course will be derived from the Ray Brook State Tuberculosis Hospital, the Tupper Lake Veterans Hospital, Will Rogers Memorial, and Sanatorium Gabriels. The skills of the research laboratories of the institutions in the area and of the practicing tuberculosis specialists in Saranac Lake will be called upon, as formerly, to participate in the program. There will also be participation by authoritative guest lecturers from different parts of the country.

Eligible and interested officers should forward requests via official channels, addressed to the Chief of the Bureau of Medicine and Surgery. Requests for attendance must be received in BuMed at least 30 days prior to commencement of the course requested. Travel and per diem orders chargeable against Bureau funds will be authorized those approved for attendance. Eligible officers are those who meet the criteria prescribed by BuMed Instruction 1520.8 of 6 February 1956. (ProfDiv, BuMed)

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Standardized Drugs Now Available

In order to alert all doctors to newer drugs which are now readily available on the Armed Services Medical Stock List, the following are described:

Procaine Hydrochloride 5 mg., 0.5 cc in a sterile plastic collapsible tube with needle is now provided at a cost of 21 cents primarily for use as a local anesthetic before venipuncture for the collection of blood in blood donor centers. Other uses of this item are obvious, especially in the field. It is tested for resistance to reduced pressure just under the equivalent of 30,000 feet altitude, so can be freely transported and used in the larger aircraft. It is further tested for resistance to cold at -30° C. for 6 hours giving it a usability in the colder climates.

Reserpine Scored Tablets of 0.25 mg., an alkaloid ester extracted from Rauwolfia Serpentina, is currently available as a non-hypnotic tranquilizer for use in tension states, neuropsychoses, and as a basic mild anti-hypertensive. Commercial trade names for this drug are: Reserpoid, Serpasil, Ran-sad, Sandril, Serfin, Serpanray, and Serpiloid. In the treatment of hypertension, it is to be stressed that this drug is a basic one and usually will have to be combined with the more potent ganglionic blocking agents for effective control of the blood pressure. Side effects are usually mild and consist of drowsiness, nasal stuffiness, bad dreams, bradycardia, mild diarrhea and occasionally, the aggravation of the symptoms of asthma, cholelithiasis, ulcerative colitis, et cetera.

Bilirubin Test Kits consisting of diazo reagent tablets and test mats are now available for the bedside testing of urine for bilirubin. Five drops of urine are placed on a test mat which absorbs any bilirubin on its surface. A diazo tablet is then placed on the spot of urine and is moistened with 2 drops of water. A positive reaction is read in 30 seconds when the spot turns blue to purple. Sensitivity and specificity are no less than that experienced with conventional laboratory methods. (ProfDiv, BuMed)

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From the Note Book

1. Rear Admiral B. W. Hogan, Surgeon General of the Navy, was presented with the Medaille de vermeil, the Medal of Honor of the French Navy Medical Service, at a special ceremony held in the office of the Surgeon General at the Navy's Bureau of Medicine and Surgery on January 10, 1957. The Medal was presented to Admiral Hogan by Rear Admiral Louis Mornu, Naval Attache for the French Embassy, Washington, D. C., (TIO, BuMed)

2. The Honorable Edward H. Cushing, Deputy Assistant Secretary of Defense (Health and Medical) accompanied by representatives of various offices of the

Assistant Secretaries of Defense and representatives of the Surgeons General of the Navy, Army, and Air Force visited military medical facilities in Arizona, California, and Kansas during the period February 3 - 16, 1957. Representing the Navy Surgeon General on the trip was Rear Admiral Bruce E. Bradley, Deputy Surgeon General of the Navy. (TIO, BuMed)

3. Captain William C. Livingood MC USN was initiated as a Fellow of the American College of Surgeons on 12 October 1956 at the Annual Convention held in San Francisco, Calif. On 16 October 1956, he was elected the national president of the Society of Military Otolaryngologists at the Annual Meeting of the American Academy of Ophthalmology and Otolaryngology. Captain Livingood has also been appointed Assistant Professor of Otorhinology at the Hahnemann Medical College, Philadelphia, Pa., for one year beginning 1 September 1956. (USNH, Philadelphia, Pa.)

4. CDR Robert L. Fleck MC USN was recently elected by the Executive Faculty of the Georgetown University School of Medicine to the post of Clinical Instructor in Medicine. (TIO, BuMed)

5. Please Note: In volume 29, Number 1, page 23, dated 4 January 1957, the manual How to Survive on Land and Sea was reported as being available from the U.S. Naval Institute, Annapolis, Md., Apparently, the impression was created that this manual was available on a no charge basis. Such is not true. The U.S. Naval Institute is a private, completely self-supporting organization and, therefore, the manual is for sale and not available for free issue. The cost of the manual is $4.00 per copy. Editor

6. The Medical Department will be featured by Navy Management Review, NavExos P-910, in its February 1957 issue. Previous issues have honored the Operating Forces, Bureau of Supplies and Accounts, and the Marine Corps. The Review, which is devoted to better management, is published monthly by the Navy Management Office. It has a normal distribution of more than 25,000 and reaches schools, colleges, U.S. Government agencies and foreign governments as well as Navy and Marine Corps readers ashore and afloat. (TIO, BuMed)

7. Composition of Foods, U.S.D.A. Handbook #8 is of major value in preparing charts showing the nutritive value of the dietary presented on Hospital General Mess bills of fare. It may be obtained from the U.S. Department of Agriculture, Washington, D. C. The Hospital Food Service Manual illustrates many guides and shows techniques for assistance in good Food Service Administration. It is published by the American Hospital Association, 18 East Division Street, Chicago, Ill. (ComptDiv, BuMed)

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DENTAL SECTION

Rear Admiral Malone Accompanies Assistant Secretary of Defense (Health and Medical) on Visit to Caribbean Area

Rear Admiral Ralph W. Malone, DC USN, Assistant Chief for Dentistry and Chief, Dental Division, Bureau of Medicine and Surgery, accompanied Dr. Frank B. Berry, Assistant Secretary of Defense (Health and Medical) on a visit to Puerto Rico and Trinidad during the period 14 - 21 January 1957. The party included the three Surgeons General and the three Chiefs of the Dental Corps of the Army, Navy, and Air Force. The purpose of the visit was to determine the possibility of consolidating medical and dental treatment facilities operated in Puerto Rico. The group also investigated the implementation of the medical and dental provisions of the Medicare Act.

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Active Duty for Inactive Reserve Dental Officers

At the present time, active duty is not available in any grade for inactive Reserve Dental officers. All vacancies for active duty for the fiscal years of 1957 and 1958 have been committed by the Department of Defense to those draft liable Dental students who graduate from dental school during these years.

Active duty, however, is available to inactive Reserve Dental officers who qualify for appointment in the Regular Navy Dental Corps. These appointments are restricted to those officers eligible for the grades of lieutenant commander and below.

Recruiting Service Instruction 315.1 permits dentists who are qualified for appointment in the grades of lieutenant commander and below and who have not had previous active duty as Navy Dental officers to apply for appointment in the Regular Navy Dental Corps.

All eligible applicants are encouraged to contact the most convenient Office of Naval Officer Procurement for the necessary forms and assistance for requesting appointment in the Regular Navy Dental Corps.

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Correspondence Training Section - Naval Dental School

In July 1953, the Dental Correspondence Training Division at the U.S. Naval Dental School, National Naval Medical Center, Bethesda, Md., was established to administer dental correspondence training courses for personnel of the Regular and Reserve components of the Dental Department.

The assigned functions of this division are expected to (1) develop the requirements on content of correspondence training courses for personnel of the Regular and Reserve components of the Dental Department covering those aspects of professional and technical training peculiar to the Navy Service; (2) compile, edit, prepare for publication by the Bureau of Naval Personnel, and administer the distribution of correspondence training courses; (3) maintain individual progress records, and evaluate and record completed courses received from Dental Department personnel.

The following is an analysis of enrollment of Dental Department personnel by course since the correspondence training section was established:

Name of Course	Enrollment
Aviation Medicine Practice	27
Clinical Laboratory Procedure	121
Combat and Field Medicine Practice	44
Functions of Officers of the Medical Department	118
Frigid Zone - Medical and Dental Practice	403
Insect, Pest, and Rodent Control	76
Medical Department Orientation	368
Manual of the Medical Department - Part I	171
Manual of the Medical Department - Part II	17
Naval Preventive Medicine	84
Pharmacy and Materia Medica	378
Radiological Defense and Atomic Medicine	77
Special Clinical Services (Blood)	45
Special Clinical Services (Dental)	637
Special Clinical Services (General)	23
Submarine Medicine Practice	25
Tropical Medicine in the Field	61
X-Ray Physics and Technique	4
Medical Department Administration	69
Physical and Psychobiological Standards	6
Total	2,754

MEDICAL RESERVE SECTION

Correspondence Courses Available to All Reserve Medical Department Personnel

Two excellent correspondence courses entitled, Manual of the Medical Department, Part I, NavPers 10708-1 (Revised 1957), and Manual of the Medical Department, Part II, NavPers 10709-1 (Revised 1957) are available to eligible Regular and Reserve officer and enlisted personnel of the Medical Department.

These courses are designed to enable Medical Department personnel to familiarize themselves with the functions of administration, organization, and management of facilities exercised by the Bureau of Medicine and Surgery. Completion of these courses will enable the enrollee to acquire essential knowledge of the significant functions of the Medical Department in its relation to the Naval Establishment ashore and afloat in all of its far-flung activities and to increase the enrollee's over all efficiency.

Because of the extent of the material, it has been divided into two parts. Each of the two parts is administered and credited as a complete course in itself. The two courses are described here together because they deal with different aspects of the same subject.

Manual of the Medical Department - Part I, NavPers 10708-1 (Revised 1957)

In addition to the delineation of authoritative methods and procedures, the material embraces discussions of approved essential organizational structure of all types of Medical Department components. These range from the Bureau of Medicine and Surgery, through the various field agencies in all areas of activities, and the regional and district medical staffs, to Medical Department organization in ships and on shore stations.

The course includes 10 objective question type assignments with their corresponding examinations.

Eligible Naval Reserve enrollees satisfactorily completing the course receive 24 promotion points and the same number of non-disability retirement points. Naval Reserve personnel who previously completed course NavPers 10708 will not receive additional credit for completing this revised course.

Since the Medical Department is guided in matter of administration by Navy Regulations, current directives of the Bureau of Medicine and Surgery, and the Manual of the Medical Department, certain chapters of the Manual

have been selected as the principal text for the course. These include chapters 1 through 14, and chapters 17, 18, 20, 21, and 22. Page changes One through Four have been incorporated in the text and it fully reflects the current position of the Medical Department on the subjects affected.

SecNav Instructions 6320.8 and 6320.9 relating to the Medical Service Dependents Medical Care and Comptroller Fiscal Policies Dependents Medical Care are furnished as Supplementary reading material, but no questions are based upon this material.

Manual of the Medical Department - Part II, NavPers 10709-1 (Revised 1957)

As in Part I, the material in this course includes authoritative standards, methods, and procedures. Here they apply chiefly to three areas. One concerns matters of property management and fiscal management; another concerns the forms and reports which are to be used on various occasions, and the maintenance of proper records; the third has to do with the proper application of standards for the physical examination of Navy personnel. Also included is material relating to treaties and conventions which is of special significance for personnel of the Medical Department.

Eight objective question type assignments make up the course.

Upon satisfactory completion of the course, eligible Naval Reserve enrollees are credited with 18 promotion points and 18 non-disability retirement points. Naval Reserve personnel who previously completed course NavPers 10709 will not receive additional credit for completing this revised course.

Text material is drawn from the Manual of the Medical Department, chapters 15, 23, 24, 25, and Appendix A. Page changes One through Four have been incorporated in this material, assuring its authenticity. Additional material is taken from Army Regulations 40-503, (new 1956) entitled Physical Standards and Physical Profiling for Enlistment and Induction.

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References That are Important to the Reservist

U.S. Navy Regulations. Sets forth the principles and policies by which the Navy is governed.

Navy Department General Orders (Series of 1948). Supplements Navy Regulations and includes orders relating to special ceremonies, commendations, organization, budget and appropriations, Presidential executive orders, and similar matters.

Bureau Manuals. Contain instructions pertaining to matters under the cognizance of the various bureaus.

BuPers Manual. Contains instructions governing the various phases of Navy personnel administration. It is divided into six parts: Part H deals with instructions relating to the Naval Reserve.

Instructions and Notices. Directives issued by the Chiefs of the Navy Department bureaus contain policy and procedure of the Navy. Instructions are defined as directives "which contain information of a continuing nature." The most important to the Medical Department Reservist are those promulgated from time to time by the Chief of Naval Personnel and the Chief, Bureau of Medicine and Surgery.

Joint Travel Regulations, 1951. Explains laws and regulations concerning travel and station allowances; sets forth the manner in which transportation is furnished, reimbursement for travel expenses, et cetera.

U.S. Navy Travel Instructions. Contains instructions relative to the travel of Naval personnel in their performance of duty or in connection with changes in duty station.

U.S. Navy Uniform Regulations. Describes uniform and contains regulations for the wearing of Naval uniform.

Navy and Marine Corps Awards Manual. Provides information pertaining to awards, medals, personal decorations, et cetera. Contains eligibility lists of all ships, units, service groups, divisions, and squadrons for certain awards.

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AVIATION MEDICINE SECTION

Manual of the Medical Department Change Relating to Aircrew Fatalities

The attention of all flight surgeons is called to Advance Change 5-3 to the Manual of the Medical Department, dated 7 January 1957. This change requires the medical officer to recommend to the commanding officer that an autopsy be done "when death occurs while serving as an aircrew member in a military aircraft."

The Human Component in Extraterrestrial Flights

by

Major Robert K. Quinnell, USAF (MC)*

(Taken in part from Tactical Air Command Surgeon's Bulletin, Vol. 6, No. 11, November 1956)

It is apparent now that an age-old dream is about to be realized for the conquest of space is within the grasp of mankind. Already rockets, some carrying animals, have advanced well into the outer fringes of earth's atmosphere and approached true space.

Physicists and engineers are developing machines and methods capable of flying to prodigious heights at fantastic speeds. From the epoch-making flight of the Wright Brothers more than fifty years ago to the present, the struggle to attain these great heights and speeds has proceeded relentlessly. This, of course, has involved activities which were designed to adapt the aircraft to the man, and/or the man to his new environment. Obvious success has attended this effort, such that, in those areas where man was markedly deficient, the aircraft was modified or equipment and understanding were given to the pilot. Dependency was placed on the remarkable ability of mankind to adapt itself to environmental changes—a feat which has given men their position of ascendancy in the animal kingdom. This same faculty will render space flight feasible.

A realization comes when one contemplates reaching the borders of space that a broad appreciation of the problems involved is required. Intelligent planning and research are necessary before successful accomplishment of this feat is possible. Whether the perspective is that of the astrophysicist, engineer, or biologist, collection of factual data of the conditions of space and the requirements of both man and machine are essential.

A great deal of work has already been performed in regard to the human component for the proposed flight. Unfortunately, the results of these investigations are rather widely scattered in the literature. It is the purpose of this paper to attempt to collect under a single heading those important physiological functions that are involved and demark the ranges of human tolerance for the anticipated problems. This then may form a basis of understanding and provide a guide for future research.

Undoubtedly, the first attempts to get piloted aircraft into space will be no more than space flights of short duration. Subsequent attempts will prolong the effort until true space travel is realized. The problems that probably will be encountered in this first flight will not be substantially

* Resident in Aviation Medicine, assigned to the Surgeon's Office Hq TAC 1955-1956. This article represents a one-year research project.

different from those of space travel except for the duration of the voyage. Certain basic physiological hazards will have to be surmounted—even for short-lived flights.

The concept of space equivalents[1] reveals that physiologic space begins at 50,000 feet and is complete, with minor exceptions, at approximately 600,000 feet. Most of the criteria of physiologic space are met as low as 120,000 feet. Flyers above this region are "in space" for all intents and purposes. It is anticipated that the initial attempt for manned space flight will leave earth on a parabolic flight path attaining a maximum altitude of perhaps 200,000 feet, then coasting back to earth. This whole flight will take less than an hour, yet it will produce nearly all of the stresses that will be encountered in true space travel. In order to consider these stresses adequately, they have been divided into several major categories to be discussed separately.

Acceleration

In order to attain the necessary velocity and altitude for this flight into space, a certain acceleration for a period of time will be necessary. These escape velocities have already been calculated and vary from 3G for 9-1/2 minutes to 30G for less than 3/4ths of a minute. The lower accelerations are easily tolerated by men, but are obviously mechanically impractical. The high accelerations may be mechanically feasible, but surely cannot be withstood by the pilot. Somewhere between these two extremes lies the optimum accelerative force to be applied.

Experiments with the human centrifuge have fairly well outlined the parameters of human endurance for sustained accelerative forces.[7] The maximum tolerance, with the end point sub-lethal only, has been found to be 15G for 5 seconds if the force is applied transversely to the long axis of the body. The maximum tolerance to transverse G has been defined as 12G for one minute. Under these conditions, however, the occupant of the vehicle could not function in a useful capacity.

Ballinger[8] has shown that even 8G for 2-1/2 minutes applied transversely to the supine man produces severe chest pain and shortness of breath sufficient to interfere seriously with function. Simply raising the head and chest to 20° from horizontal, lifting the knees to head level, thus creating an eye to heart distance of 7 inches vertically, will render a man much more resistant. In this position, 8G applied transversely can be tolerated for 2 minutes and 40 seconds and will produce only epigastric discomfort. Ten G for 2 minutes 6 seconds in this position once again will produce severe pain in the chest and shortness of breath. Under these conditions delicate hand movements can be performed such as operating light switches, but gross arm and leg movements are impossible. At the cessation of these forces, there is a prompt recovery of full function and there is no measurable residual

loss of ability. Petechiae of the skin will occur which are not troublesome, but serve to indicate that greater stresses would not be innocuous.

Except for the high accelerative forces of catapults and crashes, the escape rocket will produce the most severe accelerative stresses that men are liable to encounter. Engineering limitations at present are such that these escape rockets will probably be in several stages, most likely three in number, each fired in succession. Such a system will not produce the steady accelerative loads that are accounted for above, rather these accelerations will approximate a series of hyperbolic increases with time separated by discontinuous decreases. Since the exhaust velocity of a chemical propellant is constant, but the weight-to-thrust ratio is constantly changing as fuel is burned off, it follows that the accelerative curves must be hyperbolic.

Further experiments[9] on the centrifuge showed that manual control of a multi-stage rocket is feasible provided that a small decrement in accuracy is acceptable. Transverse forces that peak to 8G over a period of more than 100 seconds are not only tolerable, but a dual pursuit task with hand and finger motion on controls can be performed satisfactorily.

Tolerance to accelerative forces applied along the long axis of the body is, however, a different matter.[10] Severe headache, mental confusion, and muscular incoordination develop almost immediately in persons exposed to 3 or 4 negative G even if applied for only a few seconds.[11]

Man can tolerate 4 - 5G in this fashion and 1.7 - 2G more if protected by a standard anti-G suit. Accelerative forces high enough to produce blackout and dimming of vision will also produce mental confusion. Recovery time from blackout varies from 3 - 60 seconds after cessation of the increased G forces and averages approximately 12 seconds, depending upon the length of time the forces act.

In the pull-out from a dive after reentry into the earth's atmosphere the pilot cannot be depended upon to accomplish this maneuver by "feel" alone. The kinesthetic senses of the body are incapable of distinguishing individual G forces, only the resultant vectors and even this is limited. One can easily distinguish a change from 9 to 6G of force, but reduction from high G to 2G will leave the impression that there is no remaining increased G forces. The auditory mechanism does remain after vision has been dimmed by excessive forces, but there is a considerable degree of impairment. If the pilot is expected to make a successful pull-out, he must not exceed his ability to use visual cues. Motor ability remains up to 5G applied in a head to foot direction with only minor decrements in pull or push of a control column, but considerable decrease in ability to move such a column sideways.

Visual acuity is adversely affected by prolonged accelerative stress, particularly distant vision. Near vision, if the forces are applied transversely, is only minimally affected.[12] At 5G, applied transversely to a semi-supine individual, visual acuity is reduced to approximately 80% of normal. In the prone position this is reduced to as low as 60% of normal.

Speed and accuracy of movement are both affected under accelerative stresses, but not severely. At 3G, accuracy of movement is reduced by 24% and reaction time is increased by about 1/4.

Cockpit Atmosphere

A safe and comfortable gaseous environment for man above 70,000 feet can only be maintained by a self-sustaining capsule or sealed cabin. Pressurized cabins at this or higher altitudes are mechanically impractical and may even be hazardous in the ozonosphere.

In order to sustain useful life, the alveolar oxygen tension should be at least 100 mm of mercury and the carbondioxide tension should not exceed 40 mm of mercury. On the other hand, an oxygen tension above 425 mm of mercury is not tolerated indefinitely. If a 100% oxygen environment is to be used, the optimum level is probably 628 pounds per square foot.[28]

Obviously, oxygen is a constant requirement for maintenance of life, thus, it will have to be supplied continuously. On the other hand, high levels of carbon dioxide are lethal and must be avoided. Simply providing for proper levels of oxygen and carbon dioxide in this sealed cabin is not sufficient. Human metabolism also involves other end products which we are in the habit of discharging into the vast diluent of atmosphere or the water on the face of the earth. This spendthrift method of disposal is not so simply done in a small cockpit in space.[29]

From respiration, the body discharges not only unused oxygen and accumulated carbon dioxide, but small quantities of nitrogen, aceto-acetic acid, certain volatile oils, and bacterial fermentation products, such as methane and hydrogen. In urine, ammonia and ethereal sulfates are excreted in addition. In feces, there are many toxic substances which are normally so small in amount as to be non-hazardous. The toxicity of a substance is not just simply a product of time and its concentration, for many have so-called thresholds and others are so active that they act progressively on matter. Human flatus contains many toxic substances, such as indole, skatol, methane, hydrogen, hydrogen sulfide, phenol and many amines. Highly active oxidizers, fuels, lubricants and their fumes can be excluded from the cockpit by proper engineering, but these products of human metabolism are inherent in man's environment and must be dealt with in that medium.

Oxygen will, of course, be controlled in some manner external to the body. The main concern here is to keep it at a tolerable level, i.e., above 0.15 atmosphere and below 0.8 atmosphere. The rate of oxygen consumption varies depending upon exercise, food intake, and emotional control, but averages for a pilot about 614 liters per day, or 0.5 cu. ft. per hour at rest. Moderate exercise will increase this to 2.25 cu. ft. per hour. These figures may be lower in a gravity-free state, but there is no evidence to substantiate this at this time.

There are four basic methods of carbon dioxide removal: chemical, physical, air-reduction-liquifaction, or by an enzyme system. The latter is a most intriguing method; the so-called balanced aquarium. Myers[30] has investigated the use of algae for this purpose. These plants will produce oxgen, absorb carbon dioxide and some odors while simultaneously producing a source of food. At a conservative estimate, it is felt that 2.3 kg (fresh weight) of algae will supply the oxygen requirements of one man. The difficulty, however, is that this will require 240 square feet of surface for 230 liters of suspension which will be an engineering nightmare. Further refinements may be able to reduce these latter figures. Chemical removal of carbon dioxide with alkalis has been used successfully in submarines and high altitude balloon ascensions. It must be remembered, however, that these substances have a limit of absorption and saturation. Air-reduction-liquifaction methods entail usage of bulky and heavy equipment, as does the water scrubbing technique. More promise is held by the use of filters with selective permeability, but there has not yet been enough investigation performed on these methods. In any case, the gaseous mixture breathed by an aviator must not contain more than 3% by volume of carbon dioxide.

The other metabolic by-products are rather low in amount except water and they are poorly understood. For space flights of short duration, they will not present a problem. When prolonged flights are contemplated, some arrangements must be made for disposal of 1500 cc of urine per man per day, up to 480 cc of flatus per man per day (although some reduction is possible through diet restrictions). Human flatus is usually made up 45% carbon dioxide, 40% nitrogen, 10% oxygen and the remainder hydrogen, methane, and hydrogen sulfide. With the exception of hydrogen, which may be quite troublesome, these gases and liquids can be frozen and then removed mechanically.

Body odors and those of the metabolites, while not hazardous to life, yet may be important from the standpoint of morale and distraction. Masking these odors is not practical, but fortunately activated carbon filters and alkalis do quite well in controlling this variable.

Weightlessness

The reaction of humans to a prolonged state of weightlessness is imperfectly understood, since we are unable as yet to produce such a condition for longer than a few moments. While it is known that the force of gravity decreases as the inverse square of the distance from earth's center, a static zero-gravity state is only theoretical for there is no place in the universe where gravitational forces from some heavenly body are not active. One would have to ascend to an altitude of 4000 miles to reduce earth's gravity to 1/4 of that at sea level. A moving vehicle, however, can produce a sub- or zero-gravity state at any altitude provided that its centrifugal force equals

or approximates the gravitational force that is acting. This then is the circumstance that will be encountered in parabolic rocket flights.

Attempts have been made to reproduce this with success only for brief periods of time. At 15 - 25 seconds of subgravity, the only ill effect was mild airsickness after repeated exposures. As long as the subject of these experiments was able to remain firmly harnessed to his seat and had visual references, he was able to retain orientation with a moderate effort.[33] There is some reduction in accuracy of movement, but this can be markedly improved by training.[34]

Animal studies showed that there were no demonstrable cardiovascular disturbances during 60 - 100 seconds of exposure to subgravity conditions.[35]

It is important, apparently, to insure that the subject is substantially harnessed to a firm structure and has the benefit of visual orientation. Vision then is exceedingly important. Fortunately, there is no appreciable physical effect on vision under a gravity-free circumstance. Psychophysiologically, there is a high probability that there will be an effect, particularly in the transition period, from excessive G to zero G. Evidence to date indicates that visual acuity is not affected, but visual illusions are produced by alterations in stimulation during the change in gravitational forces. These oculogravic and oculogyral illusions are not recognized as inaccuracies by the individual except after a considerable time lag which can be shortened by training.[36]

One may conclude at this time that, while much remains to be learned about this phenomenon of weightlessness, the condition as it will be encountered in parabolic rocket flights will not seriously interfere with the proper performance of a pilot's task. Similarly, there will not be any serious difficulty in re-entering a positive G condition after experiencing weightlessness.

Temperature

In considering the ecological aspects of life, the principle of limiting factors becomes paramount. This biological law in effect points out that certain environmental factors such as temperature, light, and water impose limits to life by being either too abundant and excessively strong, or by being too weak and sparse. A certain minimum must be maintained and a maximum must not be exceeded. There is a third point, that of an optimum condition, lying somewhere between the two extremes.

Human beings are a part of such an ecological system. With clothing protection, man can withstand a considerable range in temperature. Survival is possible in temperatures as low as -50° F, but function is interfered with, primarily because of the bulk of the clothing. On the other hand, man can also survive temperatures of + 100° F for considerable periods of time, particularly after acclimatization. But, again, functional ability is adversely affected by excessive temperature.

In flights into space, it will be necessary to travel at exceptionally high velocities. It was formerly thought that the problem would be only one of maintaining warmth, but even in the upper reaches of the atmosphere, air molecules are still dense enough to create very high skin temperatures with concomitant heating of the cabin interior. True space, however, cannot be said to have any temperature at all, since there is nothing to absorb or conduct heat. The problem here is essentially one of absorption and reflection of radiant energy from the sun. A properly controlled balance between reflective and absorptive surfaces of the hull of the rocket can maintain a tolerable interior temperature.

The greatest problem then will be encountered during escape and re-entry into the earth's atmosphere. We must realize that there is a basic conflict between the requirements for optimum pilot function and aircraft performance. Each is a critical factor in the completion of the mission so that neither can be compromised. This is not the simple issue of man versus machine, instead, we must endeavor to optimize both coordinately. To approach such a philosophy, the time honored concept of human comfort must be abandoned and seek instead a concept of physiological and performance effectiveness that may be outside the so-called comfort zone. Full use of human adaptiveness must be realized.

Measurement of human tolerance to any stress factor must take into account other simultaneous stresses that may be present. Living is too complex to categorize in simple terms. It is not just a matter of temperature, but also humidity, air movement, clothing, metabolism, activity, and factors of acclimatization that enter into this consideration. As a result, we must resort to measurements that account for these variables, yet are feasible to make.[37] The other thermal factor of importance is, of course, humidity or vapor tension.

It has been contemplated, as a safety factor, that early pilots in these space rockets will be wearing a full pressure suit to insure a habitable oxygen environment. Such an impermeable suit with 3 clo insulation will protect a man in freezing water for about 2 hours, 1 hour in air at -30° F or indefinitely at 30° F. However, air temperatures above 50° F rapidly become intolerable while wearing such a suit unless a ventilating suit[38] is worn. Such a garment is capable of protecting a man indefinitely in a cabin temperature at 165° F provided that ventilation can be delivered at 13.25 cfm with air between 45 - 90° F and no more than moderate humidity.

There is then a bracket of limitations for human performance under thermal stress, but these boundaries can be extended somewhat by protective clothing.

Vision

As has been stated elsewhere in this paper, adequate visual reference points inside the cockpit are essential for orientation. There is, therefore,

a requirement for adequate illumination and presentation of instruments. The minimum standards for this requirement are admirably recorded in another document.[40]

Vision outside the cockpit may be important only for psychological reasons. The speeds to be encountered are such that optical apparatus must be used to supplement human visual acuity. Even with normal vision, the human eye can only identify an object that subtends a visual angle of at least 5 minutes of arc. This means that even under the best illumination, an object 5 miles distant will have to be at least 30 feet in diameter in order to be seen as a single object. In space, where there are no reflecting surfaces, total darkness may prevail. In addition, there is the problem of a time lag in perceiving and recognizing an object. The latent period of perception varies depending upon attention, amount of stimulation, and area of the retina involved. This variation is between .035 - .3 seconds. Recognition time varies between .65 and 1.5 seconds. Thus, it requires well over one second to simply spot an object; the time required to do something about it is often 2-3 times longer. Under the influence of excessive gravitational forces, this will be slowed even more. Obviously, then aids to vision will be required.

The psychological aspects of no outside vision are a separate consideration, but men have adapted to this before, as in submarines and some experimental aircraft, without serious objection.

Vibration

Vibrations of any amplitude require long periods of exposure before deleterious effects are seen. In the range of 2,000 to 10,000 cpm at amplitudes of 1/10 to 1/100 inch, symptoms of neurovascular changes do occur, often with burning pain, but only after prolonged exposure. As the frequency of vibration increases, the time required for symptoms to occur is shortened, but not less than several days. The onset of fatigue, however, is definitely influenced by vibrations of this calibre. High frequencies with very small amplitudes are often beneficial in inducing muscular relaxation, but only if the motion is constant and unvarying. Generally, however, mixed vibrations or those with relatively high amplitudes are annoying and productive of fatigue, but other wise have not been harmful during short exposures.

Radiation

The potential hazard to humans from exposure to cosmic radiation in flights to high altitude centers almost entirely upon the heavy nuclei components. Evidence to date shows that there are three kinds of hits by radioactive substances that have a biologic effect: a dense ionization column, star formation and ionization peak with thin down phenomenon. The latter is probably the most destructive in tissue. Here we find that along the pathway of the radioactive particle through the tissues, there are several thousand

roentgens of exposure which are clearly a lethal dose to the cells in that pathway.[45] For example, an ion nucleus of 100 billion electron volts (100 BEV) will produce in living tissue 40,000 ion pairs per 10 microns, or ab ut as much as an alpha particle at the peak of its ionization. At lower energy values, this figure rises to 2,000,000 ion pairs. The heaviest thin down tract ever recorded (obtained at 100,000 ft. altitude) courses through living tissue with a cylindrical diameter of 50 millimicrons and 15 mm long. This involved roughly 15,000 cells. This is a small number of the more than one trillion in the human body, but what number of these hits will prove dangerous?

Shaeffer theorizes that not all nuclei will be of this order of energy and probably only 100 per hour will end in this amount of exposure.[46]

The heavy components of primary cosmic radiation to be found at the top of the atmosphere contain a number of particles with varying atomic numbers up to Iron 26. The probability of a nuclear collision with one or more of these particles depends upon the initial kinetic energy. Below 0.1 BEV of energy, nuclear collision will not occur and all particles will pass into terminal peak and thin down. Above 1 BEV, the probability of nuclear collision is 1.

Shaeffer calculates that ionization dosages will climb from their sea level equivalent to 0.1 millirep per 24 hours to a peak of 15 millirep at 75,000 feet for the higher latitudes. This then will drop to a level of 9 millirep at 140,000 feet, then increase again slowly to twice the former high peak level.[47]

A determination of the relative biologic effectiveness of these cosmic radiations is a very complex problem. If all human responses are considered, the problem becomes even more complicated since tissues vary in their sensitivity. It would appear that the maximum dosages should be used for planning purposes—at least until a good deal more is learned.

For flights into space of a duration that is feasible at this moment, the hazard from cosmic radiation may be considered as insignificant. The International Commission on Radiological Protection lists 50 millirem as a permissible daily dosage.

Van Allen suggests that a factor of 4 be applied as an estimate of the increase in ionization dosage due to inner secondary radiation over the usual calculation of skin dose.[52] These theoretical figures are a little higher than might ordinarily be expected, but they seem to be the best available, based upon the most recent data. Even so, these data are not alarming since they represent 24-hour dosages and our first attempts at manned space flight will not be that prolonged.

This optimism is clouded by the realization that we are unable to make an estimate of the tissue damage from low energy heavy nuclei, which may be encountered at extreme altitudes.

Shielding of the pilot by means of a metal enclosure may serve only to intensify the radiation by sapping some of the kinetic energy of the particles.

To be effective, shielding would have to be several feet thick, an impractical approach. The use of hydrogenous substances, such as water or kerosene surrounding the occupant, may be used for shielding purposes, since double walled hull with the center filled with such a substance will be the optimum protection that can be afforded.

Meteors

Properly, the problem of meteors and meteorites is not a biological one except insofar as they influence the habitable environment of the crewman by penetration of the hull of the rocket. To calculate this chance that a meteoroid of a given magnitude will encounter the projected high altitude vehicle, dependence is placed upon the number assumed to strike earth in the same interval of time. This calculation takes into account the difference in size of the two objects and the shielding effect of the earth. The velocity of the vehicle can be neglected since it will be small compared to that of the meteoroid. Just how these figures are arrived at is too complicated a matter for this presentati n and the reader is referred to texts dealing with this subject. To summarize, however, it can be stated that a meteoroid corresponding to an 11th magnitude meteor would penetrate aluminum or aluminum alloy a distance of 1/8 of an inch. The diameter of such a meteoroid would be less than 1/10 of the thickness of the skin and the sum of all the probabilities of this encounter would be 5×10^{-4} in 24 hours, or one chance in 2,000. However, the factors of calculation change as the altitude increases such that at altitudes above 350,000 feet the probability of penetration becomes more important, particularly in the neighborhood of comet orbits.

The sand blast effect of micrometeorites is a more likely hazard, not from penetration aspects, but rather that of pitting of optical or control surfaces. Here an effect is much more likely to be encountered in a 24-hour period. In any case, the probability of difficulty from meteoroids for the first several journeys into space is quite remote.

Finally, we must consider the psychological impact of such a pioneering trip. There has been no direct experimental investigation for this specific endeavor. Past experience teaches that there will be no dearth of volunteers, but we must be sure that there is sufficient stability of personality to complete this unique mission. There is today a variety of psychological and psychiatric tools available that should be used to insure that the human component is emotionally strong. In addition, opportunity should be afforded these individuals to experience most of the stresses before actually beginning the flight. Use of the altitude chamber, human centrifuge, instrument trainers, and the like will prove beneficial for indoctrination purposes. Properly equipped, mentally, emotionally, and physically, man can and will succeed in accomplishing true space flight.

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